SECRET

IMPORTS RELATED TO

COMMUNIST CHINA'S MODERN WEAPONS PROGRAMS

(PRELIMINARY)

SEPTEMBER 1967

SECRET

Contents

I. Machine Building Equipment

Item Description	Relevance to Weapons Program
Seventy Jig Boring and Milling Machines. This machine is designed to do precision drilling, boring, or milling on jigs, dies, gauges, and other parts requiring high-precision work. This jig borer is capable of positioning the work piece in relation to the tool within 50 millionths of an inch.	Such precise tools are necessary in the production of inertial guidance systems and other aerospace mechanisms. This model is being used in the US for manufacturing rocket booster equipment.
Thirty-four Jig Borers have been imported. These machines are designed to do the most precise drilling, boring, or milling on jigs, dies, gauges, and other parts requiring high-precision work.	Because of their precision, jig borers are highly useful in the production of aerospace and nuclear weapons. They are also very important for the production of accurate production machinery for military and aerospace products.
Fifty-six Gear, Thread, and Tap Grinding Machines. The contract is valued at over $1 million. These are relatively small machines capable of high-precision grinding. The thread grinders, in particular, could be used to grind or finish-grind the lead screws on precision machine tools.	Acquiring precision grinders, particularly the thread grinders, would enhance China's ability to produce precision machine tools which, in turn, can be used directly in aerospace and nuclear weapons production.
Four Copy Milling Machines. These are large, complex, versatile, and accurate metal-moving machines, capable of machining a work piece by following a pattern or template.	One of the most intensive users of profiling or copying milling machines has been the aircraft industry in which complex and intricate parts must be machined. These machines have wide application throughout the machine building industry in small-lot production of complicated parts.
One Honeycomb Milling Machine. An exceptionally versatile machine for shaping honeycomb cores of asymmetrical form for airfoil assemblies for wings and helicopter rotor blades.	This machine is especially designed to finish honeycomb structures used in the wings of aircraft and rotor blades of helicopters. No application apart from aircraft industry.

Item Description	Relevance to Weapons Program
One Numerically Controlled (N/C) Boring and Milling Machine. This machine performs drilling, boring, and milling operations on large work pieces. The use of this machine increases efficiency and capacity as several different operations can be performed on one set-up. The addition of N/C increases machine efficiency (and workpiece quality) even further.	Applicable to the production of aircraft and missile components where many different operations must be performed on relatively few components.
Twenty-five numerically controlled (N/C) systems for controlling machine tools in accordance with a numerically coded program.	This N/C system can be employed by the Chinese to drive machine tools very precisely in the production of small lots of intricate parts for airframes and other aerospace components. In the US, aircraft and missile producers are the principal users of these systems.
Three plants for the production of hydraulic pumps and actuating devices.	Products of these plants can be used in the hydraulic systems of aircraft and missiles.
Technology for production of hydraulic mechanisms.	Of value in producing hydraulic equipment for aircraft and missiles.
Plant for production of electronic and pneumatic gauges for quality control in machine building.	Precision of gauges exceeds requirements of ordinary machine building and is appropriate for nuclear weapons, aircraft, and missiles.
Micro-alignment telescopes (11) for precise alignment in machining operations.	Accuracy of these instruments (+0.05 mm at 30 meters) is such that they can be used for building airframe assembly jigs. They are used also for building other large precision machines such as in aligning diesel engines.

II. Electronic Equipment and Precision Instruments

Item Description	Relevance to Weapons Program
High-quality, broad-band recorders. China has imported more than 300 expensive tape recorders in the last two years. At least 80 percent of these tape recorders fall in the $1,500 to $9,500 price range.	Rather specialized high-performance magnetic tape recording equipment is required for best results in recording multichanneled telemetry signals. Bandwidth of audio entertainment recorders is inadequate.
Instrumentation for testing rocket motors. China has imported a number of instruments capable of measuring thrust, elapsed time, temperature, pressure, and fuel flow rates in testing rocket motors and other equipment. Most of these instruments are standard industrial use products.	Intensive instrumentation is required to measure thrust, elapsed time, temperature, pressure, fuel flow rates, etc. in rocket motor testing.
Photo theodolites. These highly advanced precision optical devices were developed for the specific purpose of recording test missile trajectories. China has contracted for six of these devices, and two are known to have been delivered.	Used in missile development program.
Telemetry receiver, multichannel, transistorized. China has imported a significant number of these receivers.	Multichannel, specially designed radio receiver for gathering test data transmitted from a missile in flight.
High-speed movie cameras, 44,000 frames per second. China has received some of these and other types of high-speed cameras. Evidence on technical specifications on many of these items is limited.	For observing explosions and combustion phenomena in rocket engines.
Ultra- and super-high-speed centrifuges -- used to test the mechanical properties of materials undergoing high rates of acceleration or to separate substances of differing densities. China has imported more than 150 centrifuges in the past two years, many of them of the	Very-high-speed centrifuges are used to test the ability of solid propellants, such as are used in military rockets, to withstand very high accelerations. They are also used to calibrate acceleration measuring instruments such as are used in inertial guidance systems.

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ultra- and super-high-speed types. These include numerous types ranging from a simple laboratory centrifuge to substantial quantities of ultra- and super-high-speed varieties.	
Missile checkout equipment -- signal generator, field strength meters, oscilloscopes, analyzers, counters, frequency meters, and power measurement devices. China has received substantial amounts of advanced checkout instruments. (See Tab A.)	Used to test functioning of missile components prior to launch, e.g., temperature and pressure of propellant, electrical circuitry functioning.
Communications consoles for missile monitoring. A basic ground receiving and recording station for FM-FM telemetry is a composite assembly of standard off-the-shelf electronic components with custom interconnection circuitry for diversified recording and data presentation. Stations may vary greatly in their complexity and may be either fixed or mobile. Some of the basic components in such a system are: tape recorders, receivers, pen recorders, and recording oscillographs. China has imported communications consoles, recording and monitoring consoles, and air traffic control consoles.	Console-mounted electronic installations of this sort are used on missile test ranges to monitor and record telemetered data and to communicate with and control missiles in flight.
Vibration test equipment -- used to simulate vibrational environments and to measure natural vibrations of machinery. One imported set of vibration measuring equipment of the most advanced type included a small computer which is recommended for analyzing the results of vibration tests on airframe and rockets. The large amount of vibration equipment imported by Communist China has ranged in sizes from 45 kg. to 20,000 kg. China also has imported random vibration testers which are	The natural vibrations of missiles and aircraft and their components must be measured, and the effects of vibration on structural parts must be tested. These tests are an extremely important part of the development of missiles and aircraft.

Item Description	Relevance to Weapons Program
designed to measure any vibrating frequency within seismic vibrating frequencies by separating that frequency at will and oscillating it. Prices of imported vibration generating sets range from $2,100 to $140,000.	
Equipment for producing semiconductor diodes and transistors. China has imported more than 600 units of equipment and technology for the production of semiconductor devices. Complete plants have also been sought and some have been purchased. (See Tab B.)	Semiconductor diodes and transistors use less power and are lighter and smaller than electron vacuum tubes and are used in military radios, battlefield radar, and the like where light weight, low power consumption, or small size are important.
Gyroscopic compasses. Interlocked with a master gyroscope, of the type obtained by Communist China, several repeater compasses may be used as true bearing indicators for a radar, autopilot, course recorder, etc. China has imported a sizable number of gyrocompasses.	Precision devices required for the navigation of aircraft.
Accelerometers -- used in inertial navigational systems to sense directional and velocity changes. China has imported more than 50 of these devices.	These devices are essential to inertial guidance systems for onboard control of guided missiles, navigation of aircraft, and for submerged navigation of submarines. During missile launchings, they also sense termination of thrust.
Vacuum chambers, pumps, and associated equipment. China has imported a substantial number of vacuum chambers and vacuum pumps with capability up to 10^{-10} torr. Atmospheric pressure is about 760 mm of mercury; 10 torr is one one-hundred-billionth of one mm, nearly a complete vacuum.	Vacuum chambers and vacuum producing equipment are essential to the testing of missile components in the simulated conditions of outer space. Such equipment is required for producing semiconductors and integrated circuits, melting high purity metals, and fabricating radio tubes.
Special-purpose electronic tubes. Magnetron and klystron power tubes have been exported to China from the Free World. In addition, there is evidence of Chinese interest in other special-purpose electronic tubes such	These tubes are required for the operation of military radars and high-frequency radios.

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as traveling wave tubes, photomultiplier tubes, and many others whose characteristics are noted in Tab C. Almost 100 different types have been identified but technical characteristics cannot be matched up for all of them. Evidence is also not sufficient to determine China's success in obtaining all of these items.	
Precision microwave and UHF test equipment. About 50 different items of components and test equipment identified moving to China. (See Tab D.)	Used in airborne radar, missile radar, and ground radar.
Plant for producing printed circuits. (Inquiry) Listed as one of the items in Tab B.	Printed circuits are used in connection with microminiaturization in the production of on-board missile guidance systems and many other military electronic products.
Equipment for producing integrated circuits. China has obtained a considerable amount of equipment and technology directly related to the production of integrated circuits. Listed as one of the items in Tab B.	Integrated circuits are extremely small electronic components that consume very little power, are light, and fast in operation. They are the basis of the newest and fastest computers and make possible the installation of high-density electronic packages (such as computers) in missiles and other military systems.
Radar, for missile guidance, control, and test range tracking. More than 100 radar of various types have been shipped (tracking, meteorological, navigational). (See Tab E.)	These radars have three principal strategic uses: (1) guidance of missile during launch phase, (2) data collection from missile in flight, and (3) tracking of missile along its flight path. Some of these radar are also capable of incorporation in antiaircraft fire control systems.
Computers, analog and digital. More than 60 analog and digital computers have been shipped or contracted for by Communist China. (See Tab F.)	Ground-based computers are used for the control of guided missiles during the launch phase, the operation of early warning and ground-controlled intercept radar nets, and the design of efficient nuclear weapons.

Tab A

Missile Checkout Equipment

1. Imports of Signal Generators and Related Equipment

Type of Equipment	Technical Characteristics
Pulse	Pulse generator repetition frequency: 100 cps to 5 mc; pulse wd: 50 ns to 1 us; Risetime: 10 ns; output impedance: 75 ohms; double pulse - 2 channels
Pulse	Pulse generator repetition frequency: 100 cps to 5 mc; pulse wd: 50 ns to 1 us; Risetime: 20 ns; output impedance: 75 ohms
Pulse	High-speed pulse generator repetition frequency: 100 cps to 20 mc; pulse wd: 10 to 100 ns; Risetime: 0.85 ns; falltime: 1.5 ns; output impedance: 75 ohms
Pulse	High-speed pulse generator repetition frequency: 5 to 200 mc; Risetime: 1.2 ns; falltime: 1.2 ns; output impedance: 50 ohms; all transistorized; pulse wd: 2.5 ns to 50 us
Pulse	High-speed pulse generator repetition frequency: 5 to 200 mc; Risetime: 1.2 ns; falltime: 1.2 ns; output impedance: 50 ohms; all transistorized; pulse wd: 2.5 ns to 50 us
Pulse	Triple pulse generator repetition: 10 cps to 500 kc; pulse wd: fixed 5 ns; Risetime: Ins. 3 indepn pulses, phase-shiftable from 0 to 100 ns; attenuator: 0 to 22 dB for each pulse
Pulse	"Unit function" pulse generator repetition rate: 250 cps to 1 kc; Risetime: 0.1 ns; pulse duration: 3 ns; output impedance: 100 sl; output level: 0 to 50 V
SHF	SHF std. signal generator frequency range: 3,800 to 7,600 mc; frequency accy: + 1% direct reading; frequency stability: less than 0.05%; output impedance: 50 ohms
SHF	SHF std. signal generator frequency range: 7,000 to 10,500 mc; frequency accy: ± 1%; frequency stability less than 1%; output impedance: 50 ohms
Sweep	Sweep signal generator frequency range: 70 mc; + 4 dBM - 2 dBM; output impedance: 75 ohms

Type of Equipment	Technical Characteristics
Counters	Frequency time-interval period counter 20 mc: count capacity of 8 decades, surement of frequencies up to 22 mc and of time intervals in units from 0.1 ms to one second, from 0.5 ms to 1,000 days. Equipped with crystal: stability of 2 parts in 10^7 per week or one part in 10^8 per week. Various models shipped
Counters	Frequency time-interval period counters - frequency range: 0 to 2.2 mc; time interval measurements, in units of 10 ms to one second, between 50 ms and 10^5 seconds
Frequency meters	Frequency meter - frequency: 500 kc to 35 mc; stability: $\pm$ 2 x 10^{-6}; 1 x 10^7
Frequency meters	Frequency meter - frequency: 30 mc to 500 mc; stability: $\pm$ 5 x 10^{-5}; 1 x 10^{-5}
Frequency meters	HF Frequency meter - frequency range: 200 kc to 550 kc; 1.6 mc to 30 mc; error: 0.0001 cps
Frequency meter	Absorption type frequency meter - frequency range: 100 kc to 100 mc; measuring accuracy: above 170
Frequency meter	VHF frequency meter - frequency range: 20 to 1,000 mc; error committed in meas: below 0.0005 cps
Frequency meter	High precision frequency meter - frequency range of 8 to 12.5 gc; capable of determining X-band frequency within one mc
Frequency meter	Carrier frequency level measuring instrument - frequency range: 10 kc - 14 mc; measuring range: 10 N to +2 N; accuracy: less than 0.01 N
Frequency meter	Frequency meter - frequency range: 8.12 - 12.4 gc decade frequency measuring system - frequency range: 10 to 1,000 mc
Frequency adapter	Frequency adapter - extends the range of frequency measurement of the type 1149 from 0 to 560 mc
Frequency standards	Frequency standard - master oscillator, crystal controlled; stability: 2 parts in 10^8 per day long term. Outputs: pulse at 1 mc to 1 cps in decade sequence
Frequency standards	Microwave frequency standards

Type of Equipment	Technical Characteristics
Frequency synthesizer	Frequency synthesizer frequency range: 3.0000 to 30.9999 mc; overall instability per day: 100 cps steps, less than ± 1 1/2 cps at 27.5 mc; output impedance: 75 ohms
HF	HF signal generator frequency range: 30 kc to 30 mc/s in seven bands; accuracy: better than ± 0.5% at most frequencies, using internal crystal calibrator; impedance output: 75 ohms
VHF	VHF signal generator frequency range: 1 to 320 mc in five bands; accuracy: better than 0.05% from 20 to 320 mc and 0.3% from 1 to 20 mc/s using internal crystal
FM	FM signal generator frequency range: 2 mc to 216 mc; stability: 10^4; output impedance: 50 ohms
--	Signal generator frequency range: 2 to 4 gc
--	Standard signal generator frequency range: 10 kc to 50 mc, 9 bands; frequency accuracy: 1%; frequency stability less than 0.01%; output level: 126 dB

2. Imports of Field Strength Meters

Field strength meter	Frequency range: 25 to 230 mc, accuracy: ± 1%; input impedance: 50 ohms; measuring accy: ± 2dB; passing band wd: 80 kc (6 dB)
Field strength meter	Frequency range: 25 to 470 mc; input impedance: 50 ohms; selectivity: band wd more than 20 kc, attenuation - more than 35 dB - wide band: band wd 80 kc
Field strength meter	Frequency range: 0.5 to 30 mc; input impedance: 75 ohms
Field strength meter	Frequency range: 50 to 600 kc; input impedance: 75 ohms
Field strength meter	Frequency range: 27 to 200 mc (LF), 200 to 500 mc (HF). Input impedance: 50 ohms to 75 ohms

3. Imports of Oscilloscopes, Analyzers, and Related Equipment

Type of Equipment	Technical Characteristics
Oscilloscope	Wide band oscilloscope - vertical frequency resp: 5 cps to 7 mc; horizontal channel-frequency range: 5 cps to 2 mc; sweep time range: 0.1, 10 M sec/cm; deflection sensitivity: 0.1v pp/cmi
Oscilloscope	Multi-purpose, dual trace oscilloscope - frequency range DC to 15 MH_Z-AC; 2 cps to 15 MH_Z; Risetime: 24 ns; signal delay: 150 NS; sweep range: 23 calibrated steps up to 500 ms
Oscilloscope	Frequency characteristics: DC - 10 mc; sweep speed: 0.5 s/div - 0.5 ms/div (19 steps); accuracy: 5%; input impedance: 1 M ohm $\pm$ 2%
Oscilloscope	Sampling oscilloscope - 500 mc - 2 trace; Risetime: 0.7 NS or less; sensitivity: 10 mv/cm or more; sweep speed: 0.1 - 100 ns/cm; sweep time: 4 ranges of 10, 20, 50, 100 ns
Oscilloscope	Oscilloscope - No. of traces: 1; sweep rates: 1,000 ns/cm; band wd: 0-1,000 mc; sensitivity: 10 v/cm; Risetime: 0.35 ns; cathode ray tube: 125 mm - 24 kv; Uses: Special research
Oscilloscope	Storage oscilloscope - recording speed: 0.2 ms/div; free response DC to 10 mc; Risetime: 0.035 ms; sweep speed: 0.02 ms to 5 s/div; sweep delay: 1 ms to 50 s
Oscilloscope	Oscilloscope - DC to 1 gc; single shot photographs at 2 NS/cm; sync to over 1 gc; Risetime: less than 0.35 NS; band wd: DC to 1,000 MH_Z; input impedance: 125 ohms
Synchroscope	Synchroscope - sensitivity and frequency range: 200 micro v/div, DC to 100 kc, -3 dB, Risetime: 720 ns, delay time: 0; input impedance: 1 micro v; synch. range: DC - 500 kc; sweep speed: 1 ms/div. 5 sec/div

Type of Equipment	Technical Characteristics
Synchroscope	Synchroscope w/plug-in, sensitivity and frequency range: 5 mv - 2 V/cm (DC - 30 mc), 50 mv/cm - 20 V/cm (DC - 40 m/c); Risetime: 9 NS; delay time: 150 NS; sweep speed: 0.01 ms
Synchroscope	Synchroscope - sensitivity: 10 mv/div - 60 V/div; frequency range: DC - 10 mc; Risetime: 35 NS; sweep speed: 0.1 ms/div. - 1.5 sec/div; input impedance: 1 M ohms
Spectrum analyzer	Spectrum analyzers operating in the GH_Z range, used in conjunction with waveguide components
Spectrum analyzer	Spectrum analyzers for noise in AM, FM, and SSB signals
Spectrum analyzer	Spectrum analyzers - HF range
Wave analyzers	HF wave analyzers - frequency range: 30 kc to 30 m/c in seven bands; attenuator range: HF attenuator 0, 10, 20, 40, and 60 dB - LF coarse attenuator 0 to 60 dB in 10 dB steps; attenuator accuracy: $\pm$ 0.5 dB over 105 range; $\pm$ 0.5 dB over 120 dB range
Wave analyzers	VHF wave analyzer: frequency range: 5 mc to 300 mc in six bands; attenuator range: two external HF attenuators of 20 dB each; accuracy: HF attenuators $\pm$ 0.3 dB up to 120 mc $\pm$ 1.5 dB at 300 mc coarse IF attenuator $\pm$ 0.1 dB per step, $\pm$ 0.5 dB overall

4. Imports of Counters and Frequency Meters

Counters	Frequency counters - 10 cps to 33 kc up to 15 gc; 10 cps to 330 kc; 10 cps to 210 mc - input sensitivity: 100 millivolts ims; time base stability: aging rate, less than 3 parts in 10^9 per day
Counters	Universal counters 10 cps to 3.2 mc 10 cps to 32 mc 1 to 32 mc 30 to 110 mc 100 to 510 mc 200 to 1,000 mc

5. Imports of Power Measurement Devices

Type of Equipment	Technical Characteristics
VHF artificial load resistance and VHF output meter	Frequency range: 30 to 500 mc; error w/in 5% of max: 5%
Power source filter-attenuation band range	100 kc to 1,000 mc; attenuation factor: above 60 dB
UHF power meter	Power ranges: 0.1, 0.3, 1, 3, 10, 30 100 mv full scale; accuracy: ± 5% of full scale; bolometer: 100 ohms or 200 ohms resistance; temp. cutoff: positive or negative (barretter on thermistor)

Tab B

Equipment for Production of Semiconductors

1. Imports of Equipment Applicable to Semiconductor Manufacture and Testing

Type of Equipment	Quantity
Vacuum coating unit, 380-volt, 4-wire. Can be used for thin electrical films and complete microcircuits.	1
Vacuum evaporation metal coating equipment	
Vacuum coating units. For disposition of materials by thermal evaporation and/or sputtering. Chamber 19 inches x 25 inches high. (Note: This type of plant could well be used for the purpose of microcircuitry, but jigs are necessary; jigs were not ordered.)	3
Vacuum coating unit	2
Vacuum coater	4
Vacuum coating machine	
Ultra-high vacuum unit. Contract includes two sets of spare tubes. This unit has a vacuum chamber 12 inches in diameter and is for work usually associated with microcircuitry. These models could well be used in computer production.	2
Vacuum coating unit. This is a 12-inch diameter work chamber coating unit with four platinum/carbon rods and one set of spare parts and resistance monitor. The unit works at a vacuum of 10^{-4} torr.	1
High-vacuum coating unit. Includes 24-inch diameter work chamber, 23-inch high coating units, together with five sets of spares, rotary work holders, and rotary drum work holders.	5
Vacuum coating units. Includes 19-inch diameter work chamber coating units. These are suitable for such uses as single-layer film systems, multi-layer interference systems, or thin electrical films. Also includes liquid nitrogen traps, spare parts, and liquid gas circulating units.	2
High work chamber automatic coating unit. A 19-inch diameter x 21-inch high work chamber automatic coating unit with one microcircuit jig, spare parts, and one liquid nitrogen circulating unit.	1

Type of Equipment	Quantity
Photo-etching apparatus	2
Etching machine	2
Powderless etching machine	1
Microprober. This machine is used to test for soundness each element of a wafer associated with epitaxial planar-type transistors and diodes.	1
Reduction camera. Used to make masks for epitaxial technique of transistor and integrated circuit production.	4
High-precision reduction camera	4
Precision mask aligning and contact printer	1
All-metal, low-bed precision fully automatic focusing dark room process camera	1
Contact screen	1 case
Gold wire (0.02 mm)	200 grams
Hall effect unit, for fundamental research on properties of semiconductors	1
Hall generator probe	
Photo-resist material	Unknown
Micromanipulator. For assembly of ultrasmall components of semiconductor devices.	4
Manipulator	2
Transistor adaptor. Used to measure transistor parameters under small-signal conditions over a frequency range of 15 kc to 5 mc. For use with a radio frequency bridge.	3
Transistor alpha cut-off	1
Alpha-beta transistor measuring instrument	1
Transistor analyzers, includes valve characteristic meters and valve testers	10 62 5
Transistor curve tracer	20
Transistor curve tracer and ancillary equipment	1
Transistor curve tracer with 39 spare tubes	10
Transistor parameter measuring set	1
Transistor current gain measuring set	1

Type of Equipment	Quantity
Transistor input capacitance measuring set	1
Transistor "RBB" measuring bridge	1
Transistor measuring instrument, includes 19 types of counters	42
Transistor measuring instrument	2
Transistor measuring set, "B" measurement	1
Transistor measuring set, "RBB" measurement	1
Transistor measuring set, "CUB" measurement	1
Transistor measuring set	34
Transistor measuring set,RF noise figure measurement	1
Transistor measuring set, H parameter measurement	1
Transistor measuring set, "PT" measurement	1
Transistor noise checker	10
HF transistor noise figure measuring set with spare tubes	3
Transistor thermistor tester	1
Transistor "RBB" tester	1
Transistor VHF FT tester	1
Transistor measuring set, RF noise figure measurement	2
Transistor checker	7
Transistor measuring instrument	8
Transistor parameter measuring set	9
Transistor H parameter measuring set	2
Transistor "COP" measuring set	1
High-frequency transistor parameter measuring set	1
Transistor alpha w/beta measuring set	2
Transistor parameter measuring set	2
Transistor parameter measuring set	1
HF noise figure transistor	1
HF noise figure transistor measuring set	1
Junction-type transistor measurement set	1

Type of Equipment	Quantity
Junction-type transistor parameter measuring set	10
Transistor checker	7
Transistor tester	6
Transistor measuring set	10
Transistor gauge	1
Transistor thermal resistance measuring set	1
Transistor noise figure measuring set. Includes standard unit of three pieces for 50 cbm, 500 cbm, 5 K ohm	1
High-power transistor noise figure measuring set, includes one set spare tubes: 21 pcs.	1
Transistor "B" measuring set	1
Transistor "RBB" measuring set	2
Transistor "COB" measuring set	2
Reg. power supply	1
Ultra-high vacuum emission control unit	1
Ultra-high vacuum in-current amplifier	1
Gauge heads for vacuum pumps, glass 10^{-6} and 10^{-8} torr	10
Ultra-high vacuum ion current amplifier with emission control unit	1
Ultra-high vacuum ion current amplifier with pre-amplifier	1
Ultra-high vacuum eq. (10^{-9} torr), including ionization control units Pirani gauge heads	4
Ultra-high vacuum pumping system, power supply	3
High-vacuum pumping unit	1
High-vacuum pumps with nonreturn valves	2
Special high-vacuum pumping unit for use with Reichest hot chamber vacuum camera	3
Measuring and control units for vacuum units	
Vacuum fusion analyzer	2
Ionization gauge heads (10^{-6} and 10^{-8} torr)	10
High-vacuum ionization gauge (10^{-6} torr)	1

Type of Equipment	Quantity
Ionization Pirani gauge	1
Super-high vacuum gauge (10^{-4} to 10^{-11} mm of mercury)	7
Vacuum ionization gauge	4
Ultra-high-vacuum ionization gauge	5
Vacuum gauge	60
Diffusion pump	1
Diffusion pumps with liquid hydrogen traps for ultra-high-vacuum work	
Vacuum forming machine	1
Pellet bonder with accessories	1
Wire bonder with accessories	1
Nailhead bonder with accessories	1
Welding machine (for transistors). Negotiation for welding machines for the manufacture of transistors first noted in May 1965. Actual shipment not confirmed.	
Electron beam welding equipment	3
Electron beam welding equipment 10 x 30 x 448 inches, vacuum 10^4 torr, 30 kv, 250 volts line current	1
Welding machine	1
AC electric arc welding machine	1
Composite wire electric and carbon dioxide gas semiautomatic arc welding machine	1
Electrolytic condenser spot welder	1
DC electrolytic condenser welding machine	1
DC pinch welding machine	1
Condenser-type welder H-5A-1002 automatic sealing machine. Negotiations reportedly under way in September 1965.	1

2. Inquiries and Imports of Complete Semiconductor Plants and Related Facilities

Transistor production facility (Inquiry)

Tantalum and ceramic capacitor plant

Tantalum-foil capacitors, which have a very high ratio of capacitance to volume, are reportedly important where small size and low weight are required in the design of electronic equipment. China's interest in producing tantalum capacitors at this time could very well indicate a requirement for micro-electronic circuits.

Semiconductor manufacturing plant

This contract covers a semiconductor manufacturing plant. The contract was reportedly signed between March and May 1966.

Printed circuit manufacturing facility

A Chinese inquiry showed interest in a complete manufacturing facility, including machinery and technology, for manufacturing copper clad phenol resin laminated sheet, and printed circuit boards.

Know-how for printed circuit manufacturing (Inquiry)

Glass-sealed germanium diode manufacturing plant

China is negotiating for the purchase of a glass-sealed germanium diode manufacturing facility and associated technology. China would provide its own germanium crystal mounting equipment and the product inspection equipment. The Chinese want a plant with the capacity to produce 4,000 glass-sealed diodes per hour.

High-speed switching transistor manufacturing facility

China wants to purchase sufficient equipment (and presumably the associated technology) for an annual production of one million low-power, high-speed germanium switching transistors. Such transistors would find wide application in the development of native high-speed computers and communications apparatus. China also wants the plant to have a capacity to produce annually five million high-frequency, low-power diffused germanium transistors.

Silicon strain gauges

China reportedly is negotiating for the purchase of a licensing agreement for the manufacture of silicon semiconductor strain gauges.

Type of Equipment	Quantity
Vacuum chamber coating unit. A 19-inch diameter chamber coating unit, 5 x 10^{-6} torr; one extra photocell; a preamplifier for measurement of film in transmittance, one liquid nitrogen circulating unit; one electron bombarded source; one set of spares.	1
Vacuum coating unit. Inquiries for 19-inch and 24-inch vacuum coating plants. The 24-inch plant is generally for the coating of articles of the decorative type. The 19-inch plant is a more sophisticated unit and suitable for crystal coating as well as microcircuitry. It may also be used for multilayer interference systems.	
Vacuum coating plants. Vacuum specified 5 x 10^{-7} torr, quotations for two sizes: (a) 300 to 500 mm and (b) 600 to 1,800 mm, together with jigs which would indicate that the units would probably be used for microcircuitry.	30
Vacuum coating unit. 19 inch diameter, 25 inches high.	3
High-vacuum coating units.	8
Rich vacuum coating units with accessories	3
High-temperature solid diffusion furnace	1
Vapour diffusion furnace	1
Vacuum sintering furnace	1
Hydrogen filling heating furnace	1
Filtering units. Electronic companies use this type of filter in making transistors.	70
Slicing machine. This machine is designed for use in research and testing and is made up of four units: cutter, crystal light beam measuring unit, oil pump, and slicing unit.	1
Slicing machine	1
Slicing machine	1
Slicing machine and spare diamond saws (100 pieces)	1
Semiconductor manufacturing plant, includes: filament drawing and cutting machine, filament drawing and tying machine, and lathe	1
Photo-etching machine. This machine is designed for applying minute and accurate etchings or the selective scatter technique using such etchings. Photo-resistant material is applied to the object to be etched and exposed to ultra-violet light through a negative (mask) placed over it. Used to make semiconductors by epitaxial technique.	1

3. Instrumentation Imported which is Applicable to Failure Analysis in Transistor Manufacturing

Failure-analysis laboratories for semiconductors can range in size from little more than a home workshop, with only basic electrical measuring instruments, to large research facilities, with such sophisticated instruments as the scanning electron microscope. The equipment depends on the type of tests to be performed, and these fall into three categories:

a. Mechanical and physical failure
b. Material defects (deterioration of inferior materials)
c. Contamination from unclean processing or defective packaging

Instruments for these types of analysis, while essential for transistor failure analysis, are also found in advanced chemical and physical research laboratories. Communist China's importation of such equipment is far in excess of the quantity necessary for failure analysis research on semiconductors. It is important to note that Communist China currently is emphasizing the importation of highly advanced and very costly instrumentation, such as electron scanning microscopes, electron microscopes, and other advanced types of microscopy and spectroscopy instrumentation, although none of these instruments are essentially unique in failure analysis laboratories. Such instruments range in price from $15,000 to $50,000 each.

Type of Equipment	Technical Characteristics
Physical measurements	
Optical microscopes	3x to 2,000 x, 0.5 micron
Electron microscopes	Less than 10 angstroms or better, 100 angstroms apart
Interferometers	Single beam, 300 angstroms; multiple beam 25 to 10 angstroms
Profilometers	25 to 100 angstroms
Electron diffraction microscopes	Reflection needs 1 mm sample; transmission less than 1,000 angstrom sample size
Spectroscopes	
Binocular microscopes	
Electron scanning microscopes	0.05 to 0.5 micron
X-ray diffraction equipment	0.5% to 10%; 0.05 to 0.3 and 10 to 1,000 micron ranges; over 5 microns apart, 5,000 psi or 500 ppm strain over area 0.010 inch across

Type of Equipment	Technical Characteristics
Tensile testers	0.1 gram
Strain gauges	1 ppm over 0.015 in.
Optical comparators	
Microprojectors	
Contour projectors	
Toolmaker microscopes (for x and y measurement)	
Coordinate measuring microscopes	
Interference microscopes	
Electrical measurements	
Oscilloscopes	
Curve tracers	
Meters, capacitance and inductance bridges	Capacitance - 10^{-17} farads, static
X-Y recorders	
Standard signal detecters	
DC null detectors	
Variable band pass filters	
Resistivity measurement apparatus	
X-ray spectrometers	10 to 1,000 ppm
Chemical measurements	
Absorption spectroscopes	2 ppb of Mg or Zn in water - atomic - <1 ppm of Al, Fe, Co, or Ni
Emission spectroscopes	1 ppm of most elements
Mass spectroscopes	0.02 to 200 ppm 10^{-13} torr.
NMR spectrometer	2,000 ppm, analysis suitable for structural analysis
ESR spectrometer	10 inch unpaired electron spins/cc
Thermal measurements	
Thermal plotters	2^{o}C over 0.00035 in diameter

Tab C

Interest in Special-Purpose Electron Tubes*

Technical Characteristics
1. Parametric amp. 15 to 22 gc
2. 7.5 to 11 gc, 7 to 10 gc
3. 9.1 to 11.0 gc
4. 8500 to 9600 mc; local oscillator klystrons
5. 6.2 to 7.1 gc
6. 8.7 to 9.5 gc
7. 4240 to 4910 mc
8. 4,000 to 11,000 mc
9. 4.0 to 11.0 gc
10. 2 to 4 gc FW tube
11. Cathode ray tube
12. 0.98 to 1.2 gc
13. 4.61 gc
14. 2.856 gc
15. 67 to 73 gc
16. 73.5 gc (Magin)
17. 31 to 36 gc
18. 35.1 to 39.7 mc
19. C-band - 4,000 to 11,000 mc
20. L-band - 1,600 to 4,600 mc
21. MM-band - 80,000 to 92,000 mc
22. Ext. cav. klystron - 550 to 3 000 mc
23. Ext. cav. klystron - 1,600 to 5,500 mc
24. Amplitron - 2,900 to 3,100 mc/5
25. 2,700 to 2,900 mc
26. K-band magnetron 23,780 to 24,300 mc
27. 0.96 to 1.215 gc

* Items listed included both inquiries and imports. It is not possible to identify which of these items have been shipped; however, it is known that substantial quantities of items of these types have been purchased.

Tab D

Imports of Precision Microwave and UHF Test Equipment

Type of Equipment	Technical Characteristics
Adjustable shorts, attenuator, waveguide	Frequency measuring range: 1 to 4 gc; 5 to 10.0 gc
Barretter	Frequency measuring range: 0.5 to 10 gc; 0.05 to 3 gc
Barretter mount	Frequency measuring range: 0.05 to 3 gc
Bolometer mount	
Coaxial attenuator	Frequency measuring range: 2 to 10 gc, 3 dB; 6 dB; 10 dB; 20 dB; 6 to 9 gc, 3 dB; 6 dB; 10 dB
Coaxial detector	Frequency measuring range: 1 to 10 gc
Coaxial impedance attenuator	Frequency measuring range: 1 to 6 gc, 60 $\pm$ 1 dB
Coaxial measuring equipment (n.e.c.)	
Coaxial line transformers	
Coaxial matched loads	Frequency measuring range: 0.1 to 4 gc, VSWR 1.5; 1 to 2 gc, VSWR 1.1; 0.1 to 4 gc, VSWR 1.2; 0.4 to 1.0 gc, VSWR 1.2
Coaxial switch	
Coaxial transmission adapters	Frequency measuring range: 0 to 10 gc, VSWR 1.5; 0.3 to 11 gc, VSWR 1.5
Coaxial variable short-end	
Calorimetric power meter	
Crystal detector mounts	
Detector elements	
Directional coupler	
Directional coupler, coaxial	

Type of Equipment	Technical Characteristics
Dual tuning matched	Frequency measuring range: 0.4 to 40 gc, VSWR 10; 0.1 to 10 gc; VSWR 10
Dummy load	
Echo box	
Frequency meter	
Frequency meter, heterodyne	
High sensitive receiver	
Klystron tube mount	
Load, matched	
Noise generator	
Non-reflective terminal tester	
Phase shifter, coaxial	Frequency measuring range: 1 to 4 gc
Power meter	
Resonator	
Shortend, coaxial	
Signal generator	Frequency measuring range: 2 to 4 gc
Spectrum analyzer	
Slotted line	
Standing wave amplifier	Frequency measuring range: 1,000 cps ± 4.0 cps; 14 dB
Standard wave detector	
Stub tuner, coaxial	
Thermal compensation input meter	
Thermistor	Frequency measuring range: 0.1 to 10 gc; 0.05 to 2 gc; 0.1 to 10 gc; 0.5 to 10 gc
Thermistor mount	Frequency measuring range: 0.5 to 10 gc, 1 mw; 0.5 to 10 gc, 10 mw, 0.5 to 3 gc, 1 mw; 0.1 to 10 gc, 10 mw; 1 to 10 gc

Type of Equipment	Technical Characteristics
UHF Standing wave tester	Frequency measuring range: 0.1 to 1 gc
Unilateral tube	Frequency measuring range: 0. 2 to 12.4 gc, 24 dB
Variable attenuator	Frequency measuring range: 0.2 to 12.4 gc, VSWR 10.2
Waveguide bridge	

Tab E

Imports of Radars

Quantity	Type of Equipment	Technical Characteristics		
		Frequency (megacycles)	Pulse Repetition Frequency	Pulse Width
2	Naval aid (electronic)	9380/9440	1000 2000	0.5, 1.5, 0.5
2	Naval aid (electronic)	9320/9500	1100	0.1, 0.3
	Meteorological	9300/9500 (?)	250	0.2, 2.0
4	Meteorological	9300/9500	250	0.5, 2.0
2	Naval aid (electronic)	9410/9480	1000	0.5, 1.0
26	Naval aid (electronic)	9345/9405	1000	0.1, 0.5
5	Naval aid (electronic)	9320/9480	1000	0.1, 0.5
10?	Naval aid (electronic)	9380/9440	500/1000/2000	1.2, 0.5, 0.15, 0.05
13	Naval aid (electronic)	9380/9440	1000/2000	0.5, 0.15, 0.05
4	Naval aid (electronic)	9345/9405	1000	0.1, 0.5

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Quantity	Type of Equipment	Frequency (megacycles)	Pulse Repetition Frequency	Pulse Width
		Technical Characteristics		
5	Naval aid (electronic)	9395/9495	1100/2200	0.5, 0.2, 0.6
2	Missile tracking (4 sets reported as requested by Chicoms)	1685	250	1
1				
1 (negt., 16/11/64)	Meteorological	5300	260	2.0
5	Meteorological	5265/5335	310	1
4				
1		5300	250	2
1				
2				
10	Marine			
3	Marine			
4	Weather			
3				
4				

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Tab F

Imports, Contracts, and Inquiries - Digital and Analog Computers

Quantity	Type of Equipment	Technical Characteristics: Number of Operational Amplifiers	Technical Characteristics: Multiplier Accuracy	Comments
1	Analog computer	72	± 0.3%	This computer is a single-unit, mounted device. It has 64 amplifiers (?) and 64 potentiometers which permit a large capacity equal to an ordinary medium-sized analog computer. This computer can handle high order differential equations or multidimensional simultaneous differential equations. Can be used for one-shot operations and also for repeated operations.
5	Analog computer	80	± 0.1%	Reported shipped to China by source; not confirmed.
4	Analog computer			0.1 percent AC (400 kc/s) machines developed from gun fire computers.
5	Analog computer			Inquiries in early 1965 for a computer having 48 "steps" reportedly led to a contract for these computers. Accuracy: one part in 10^4 Amplifier and potentiometer complement variable from several tens to several hundreds. Easy and rapid setting in coefficients through combined use of ganged potentiometers (course-Firs) 4 decade digital keyboard and monitoring digital voltmeter.

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Quantity	Type of Equipment	Technical Characteristics: Number of Operational Amplifiers	Technical Characteristics: Multiplier Accuracy	Comments
1	Analog computer	60		Reported in COCOM returns for December 1965 as for use by Electronic Engineering Dept., Shanghai University. Reported to have been shipped.
5	Correlation calculator			This computer is a magnetic tape type of analog correlation calculator with a delay mechanism built in between a set of two channels fixed heads. It is capable of automatically calculating both auto-correlation and cross correlation of two sets of analog data, F(+) and G(+), for a range of 1.25 cps to 300 cps.
1	Analog computer	42		
2	Electronic analog computer	30		
1	Analog servo resolver			
1	Analog computer	48		
1	Analog computer			The computer had the following features: (1) summary with a rated accuracy of 0.05% or less, multipliers with a noted accuracy of 0.5% or less, and function generators which are not of independent setting method. (2) 28 summaries, 12 integraters, 4 multipliers, and 4 function generators.

Quantity	Type of Equipment	Technical Characteristics: Storage Cycle Time (microseconds)	Technical Characteristics: Internal Storage Capacity	Comments
1	Digital computer			This computer reportedly is to be used in a data reduction center for seismic equipment.
1	Digital computer	3	8-131	This is a medium-class machine.
1	Digital computer			Negotiations; no evidence of contract.
1	Digital computer	6	16	
1	Digital computer	2	16	
1	Digital computer	2	32	
1	Digital computer	3.5	8-131	
1	Digital computer	3.5	8-131	
1	Digital computer	24	4-8	
1	Digital computer	3.5	8-131	
1	Digital industrial and scientific computer			Technical design based on synmag magnetic logic elements and transistorization guaranteeing outstanding robustness.

Quantity	Type of Equipment	Technical Characteristics: Storage Cycle Time (microseconds)	Technical Characteristics: Internal Storage Capacity	Comments
	Digital industrial and scientific computer (continued)			Operating memory based on large-capacity magnetic drum. Word output 33 linear signs. Output for fast tape puncher, electrical typewriter, plotting table, etc., or for action in the elements of a regulation chain. Provision for programme interruption by external action, e.g., a priority programme can trigger the scanning of alarm circuits.
3	Digital electronic data prec. system	2	8	Contract signed.
1	Digital medical data processing computer		10^5	Specs available.
1	Digital process control computer	5	4-32	This process computer for an oxygen furnace was to be ready for shipment at the end of February 1967. Note: The Chinese intend to build five more oxygen steel plants themselves, for which automation equipment will be needed.

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Quantity	Type of Equipment	Technical Characteristics: Storage Cycle Time (microseconds)	Technical Characteristics: Internal Storage Capacity	Comments
6	Prec. electronic computer			Reported to be used in scientific research and possibly automation.
1	Process computer			
1	Computer			Shipment not confirmed; possibly for use with chemical analysis instrumentation.
1	Computer			
1	Digital computer			
1	Digital computer			
1	Digital computer			

Quantity	Type of Equipment	Technical Characteristics: Storage Cycle Time (microseconds)	Technical Characteristics: Internal Storage Capactity	Comments
1	Computer			
1	Computer			
1	Computer			This computer is believed to be used in conjunction with vibration test equipment.
1	Computer system			
1	Digital process control computer			Reportedly being used to control a steel furnace.
1 or more	Computer			
1	Digital computer	5	4-32	The Chinese showed an interest in this computer. One of this series reportedly was sold to China. It is allegedly used in the automation of an ore conversion plant.
	Digital computer		8[1]	This digital computer, a digital data logger, and analog electronics instrumentation reportedly contracted for. Contracts also included an analog computer.

III. Metallurgical Equipment and Materials

Item Description	Relevance to Weapons Program
One ton, high-frequency, vacuum induction melting furnace (maximum heating temperature with use of stamped MgO crucible is 1700°C). Two 500-kg, high-frequency, vacuum induction melting furnaces (maximum heating temperature with use of stamped MgO crucible is 1700°C). Two 150-kg, high-frequency, vacuum induction melting furnaces (maximum heating temperature is 1700°C). One 3-ton and one 5-ton, high-frequency vacuum induction furnace. One 1-ton, semicontinuous, vacuum induction melting furnace. All of these furnaces are used to produce high-purity metals, including stainless and other alloy steels and refractory metals and are part of the complete tantalum plant listed below. They are particularly useful in the first stages of processing the refractory metals to metallic form and are usually used in conjunction with vacuum-arc, consumable electrode, or electron beam furnaces in the second stage of the melting process.	Stainless steels produced by the use of these furnaces are used where corrosion or heat resistance is required in atomic energy and missile applications. The refractory metals, principally tungsten, tantalum, and molybdenum, have general fields of application to advanced weapons: (1) solid-propellant rockets; (2) lifting and guideline structure for glide re-entry vehicles; (3) liquid metal containment for nuclear space power systems; and (4) nuclear power reactors. Tantalum-tungsten alloys are used in rocket-engine parts; tantalum is used for heat shields for rocket motors; tungsten is used for rocket nozzles and in some forms in parts for missiles from the nose cone to the tail; molybdenum is used for nozzles, leading edges, numerous structural parts of missiles, tubing, heat exchangers, heat shields, and structural parts in nuclear energy and chemical industries.
One 120-kw electron beam furnace. To be used for producing tantalum ingots. A complete line of equipment is included for the processing of refractory metals, including rolling mills, slitters, and other auxiliary equipment. A complete plant for processing refractory metals (see hot and cold strip mill and tube processing plants below).	The applications of these refractory metals in advanced weapons and nuclear energy are the same as for the furnaces listed above. In addition, tantalum foil is used for capacitors in miniature circuits for both military and industrial applications.
This facility reportedly can process zirconium, titanium, hafnium, and their alloys as well as the refractory metals, tantalum, niobium, tungsten, and molybdenum.	These metals are also used for leading edges, skins, and structural members for hypervelocity atmospheric and reentry vehicles, rocket combustion chambers, nozzle inserts and skirts, vanes, and blades for advanced gas turbine engines.

Item Description	Relevance to Weapons Program
One 4-high hot strip mill for tantalum. One 4-high cold strip mill for tantalum. Capacities: Hot mill: 5,500 tons per month Cold mill: 4,000 tons per month Hot mill capable of producing tantalum sheets 4 mm thick by 23.2 meters long. Cold mill capable of reducing hot-rolled sheets to 1 mm thickness. This equipment may be part of the complete tantalum-processing plant described above.	Wide, thin sheets of tantalum such as these would have applications in missiles and as liners for nuclear reactors.
Tantalum tube processing plant. Capacity: 2 tons per month of tubing with diameters 0.5 mm to 50 mm. This equipment may also be part of the complete tantalum-processing plant described above.	Used as fuel-container material in plutonium and other fast nuclear reactors; also used in spinnerets for textile machines, surgical and dental instruments, and producing special optical glass.
Sale of chemical technology for tantalum metal production. The process noted in items above involved an electronic process only. (Inquiry)	Applications for advanced weapons as previously described. Chinese interest indicated use of tantalum as a nuclear reactor fuel cladding material.
One 22-ton vacuum-arc, consumable electrode melting furnace. One 1-ton resistance type vacuum melting furnace. This contract was for detailed technology, the aid of 4 to 6 technicians, and detailed drawings of all parts.	The furnaces are used for processing alloy steels, copper, and copper alloys, and tantalum of high purity.
One 5-ton vacuum-arc furnace, fully automatic and remotely controlled. Used to produce high-purity alloy steels and refractory metals.	Applications for advanced weapons same as noted for furnaces above.
Six ultra-high vacuum, electron beam coaters. The smaller models are designed for research and small-scale production of thin films of refractory metals. The larger models are for large-scale research and development of thin film deposition	The miniature circuiting and computer parts processed by this equipment are necessary for guidance systems for missiles.

Item Description	Relevance to Weapons Program
of various materials and for production of micro-modules, semi-conducters, integrated circuiting, switching elements, and many devices for computers.	
One vacuum melting furnace and one rolling mill for the production of titanium; includes technology for melting and rolling. Annual capacity: furnace, 1,200 tons; rolling mill, 2,000 tons. (Inquiry)	Titanium is used for military aircraft in the airframe and power plant. In airframes for: firewalls, skin, landing-gear components, hydraulic tubing, oil and fuel tanks. In powerplants for: compressor disks, blades, compressor housings, and retaining rings. Titanium is used for missiles in solid-fuel cases for retrorockets, solid rocket motors.
Two rolling mills designed to operate under vacuum and reducing atmospheres. Reportedly to be used to produce uranium bars and plates. Could also be used to produce bars and plates of refractory metals where oxidation would create a problem.	Atomic energy and advanced weapons development. Uranium bars and plates used in nuclear reactors. Refractory metals used in nuclear reactors and advanced weapons as previously noted.
Four Sendzimir-type rolling mills. These mills produce ultra-thin strip, sheet, and foil to close tolerances of stainless stell, titanium, and refractory metals.	These mills used to produce materials used for military aircraft and missiles.
One 20-roll "planetary" mill for rolling thin strip tantalum, niobium, platinum, iron, stainless steel, and zirconium. This might be referred to also as a cluster mill, depending on whether it is a cold or hot process.	This mill used to produce materials used for military aircraft and missiles.
Technology and equipment for producing "grain-oriented" silicon steel electrical sheets. Grain oriented electrical sheets are of high quality, low core loss. (Inquiry)	Used in guidance systems for missiles.

Item Description	Relevance to Weapons Program
One high-pressure autoclave - 60,000 p.s.i. with small capacity (500 cc) for use in high-temperature work such as powder metallurgy, atomic energy applications, gas pressure bonding of dissimilar metals, such as molybdenum, zirconium, aluminum, and beryllium, cladding of uranium with zirconium and zircaloy, and cladding of zirconium hydride with types 304 and 307 stainless.	Used for the production of nuclear reactor cones, rocket nozzles, nose cones for missiles.
One cold-strip mill and auxiliary equipment for the production of stainless steel strip and sheet. Installation designed to cold-roll strip stainless steel up to 48 inches in width and 0.0101 to 0.25 inch in thickness.	Stainless steel strip of these dimensions has applications in military aircraft. In the US, stainless is being replaced gradually by titanium. China's ability to substitute titanium for stainless is quite limited, however.
One beryllium metal processing plant, including equipment and technology. (Inquiry)	Used for moderator and reflector material, as neutron source material, and as canning material for fuel elements in nuclear reactors. Used in gyroscopes, accelerometers, parts for inertial guidance systems, and as heat shields in missiles and space vehicles. Beryllium-copper is used in miniature electrical and electronic components.
One beryllium oxide processing plant. (Inquiry)	Beryllium oxide is used in nuclear reactors. Also used in high-voltage electrical porcelains, insulators, and spark plugs.
Four tons of beryllium metal in the form of foil and circles.	Beryllium metal in these forms could be used in atomic energy applications or missiles. The specific parts are not known, but it is likely that they were used as reflectors for nuclear reactors.
11.5 kilograms beryllium powder	Probably made into parts for gyroscopes, accelerometers, computers, or inertial guidance instruments by the powder metallurgy process.

Item Description	Relevance to Weapons Program
90 kilograms molybdenum bars.	Molybdenum in bar form is used for structural parts in nuclear reactors and in missiles.
"Brunswick Filament" - a felt metallic filtering cloth made of nickel-chrome stainless; also made from tantalum. Other name: Brunsmet MF-2. (Inquiry)	Material designed and used for filtering rocket fuel and for purifying air from nuclear reactors.
11,340 tons, grain-oriented, silicon steel, electrical sheets. Thickness 0.008 inch and highest quality.	Used in guidance systems for missiles.
5,000 to 10,000 tons seamless, stainless steel pipe, 2 to 15 inches outside diameter, std. to extra heavy wall, stainless grades 304, 316, 321, and 347.	The quality, range of sizes, wall thickness, and stainless grades specified indicate this pipe was for missile use; also, could be used for high-pressure ammonia nitrate or caustic chlorine chemical plants.
Explosive metal-forming equipment and related technical data. Explosive metal forming of unsymmetrical parts out of aerospace metals such as titanium or molybdenum steel alloy to close tolerances. It is substantially less expensive than coventional metal-forming methods. (Possible contract)	Explosive forming is in many cases the most economic way to shape aerospace metals -- and in some cases it is the only way. It is of great importance to aircraft and missile parts production. Moreover, explosive forming can produce parts to such close tolerances that little or no finishing is required.

IV. Chemicals and Chemical Equipment

Item Description	Relevance to Weapons Program
Ammonium perchlorate. Purity of product -- 99 percent or higher. A high explosive.	Used in various composite military explosives, as oxidizer in composite solid propellants for rockets and missiles, and in making pyrotechnics.
Diethylene triamine. Purity of product -- 99 percent.	Applicable as high-performance, storable missile fuel. Possibly for test purposes by China.
Dimethylamine. Product is a gas and shipment is in an aqueous solution of 40 percent purity.	Can be used as intermediate for production of an advanced missile fuel (UDMH-unsymmetrical dimethyl hydrazine).
Hydrazine (anhydrous grade). Purity of product -- 98.5 to 99 percent. (Inquiry)	Can be used as a high-performance missile fuel. It ignites spontaneously with strong oxidizers such as liquid oxygen.
Silicone fluids and greases uniquely useful as lubricants and hydraulic fluids over an extremely wide range of temperature because they are stable, inert, and show low viscosity change.	Direct relationship to military equipment, aircraft, missiles, and the atomic energy program. For example, Dow-Corning types 703 and 704 are used in the manufacture of power and microwave tubes, deposition of films and transistors and capacitors, metallized films for printed circuitry, insulating and protective films for missile assemblies, metal coatings for high-temperature bearings, and the processing of atomic energy metals and fuels. Because of small availability from domestic output, use in China probably is predominantly military.
Polytetrafluoroethylene (PFTE materials - Teflon type, DuPont tradename). A plastic that is highly chemical-resistant (even at high temperatures) and combines excellent dielectric properties, low friction coefficient, high wear resistance, and great strength and stability under extreme temperature ranges. Sizable imports on a continuous and rising basis.	Chemical and physical properties make fabricated end products applicable in the nuclear and missile programs and in the aircraft and communications industries. (See Teflon plastic fabricating equipment below.)

Item Description	Relevance to Weapons Program
Teflon plastic fabricating equipment (two units). Machinery for extruding, molding, or otherwise forming Teflon plastic items. Complete 40-mm extruder machine for Teflon dispersions imported in 1965. Details of machine imported in 1967 unknown.	Used to produce end products mainly for direct and indirect military application. Can be used to make components (piping, gaskets, and sheeting) required to maintain and possibly to expand China's gaseous diffusion plant. Could fabricate items with rocket and missile application such as gaskets, tubing, pump parts, transfer hose, electrical insulators, o-rings, and liquid oxygen seals. Could give strong support for production of high-quality electronic parts, including condensers, coils, and switches, which must withstand extremes in temperature. Extensive applications possible also in aircraft manufacture.
Unsaturated polyester resin plant and technology for plastics-reinforced glass fiber. Complete plant for producing polyester resin. Details on capacity unknown but plant has two resin-producing units served by a heating system that is automatically controlled to predetermined termperatures.	Could be used in conjunction with fabrication of glass filament-wound shells applicable to castings for solid and liquid missile propellants and exhaust nozzles. Also could be used to make radomes and other aircraft structural parts. Polyester resins can serve as adhesives in double-base propellants. Reinforced polyester products are often lighter than aluminum, stronger than steel, and are resistant to corrosion, chemicals, erosion, and extremes in temperature.
Polyurethane rigid-foam slab plant and ancillary equipment. Plant described as medium-size, but capacity is unknown. Additional equipment acquired was a spray/dispersing machine. Process technology probably included but China apparently dependent on imports of basic chemical intermediate, toluene diisocyanate.	Part of the plant might be used to produce urethane prepolymer for use as a fuel binder for solid fuel missiles.
Helium liquefaction and recovery equipment. Fully automatic equipment with a 10-liter-per-hour liquefier and a 5-cubic-meter-per-hour recovery unit. (Inquiry)	Liquid helium can be used as a blanket gas or coolant in nuclear reactors and as a pressurizer for liquid fuel missiles. Research work on superconductivity of materials calls for liquid helium.

Item Description	Relevance to Weapons Program
Hydrazine hydrate plant (no details available). (Inquiry)	Product is starting material for producing anhydrous hydrazine which can be used as a storable missile fuel.
Micron particle size separator and superpulverizing equipment. Equipment includes three pulverizing mills. Chinese intended use was to process talc. With few small modifications, however, the equipment could be converted for processing solid propellant ingredients (fine-grained) such as ammonium perchlorate.	Equipment has capability for processing solid propellant ingredients (fine-grained) such as ammonium perchlorate. (See Ammonium perchlorate, above.)
Technology for production of nitroglycerin. Details of contract unknown.	Nitroglycerin, with nitrocellulose, is used to formulate military explosives and solid propellants of double-base type. China probably has plans to develop a capability for casting large-grained composite solid propellants for missiles. The technology acquired could promote this objective.
Methylchloride plant. Few details known indicate that the plant will produce methylchloride, which, in turn, will be the starting material for manufacture of silicones and semiconductor grade silicon. This plant is part of an integrated complex whose construction apparently has high priority.	Silicone products in various forms (oils, greases, fluids, and rubber) are important in missile hardware, military aircraft, and in the electronics industry. (See Silicone fluids and greases, above.) Silicone use in China probably would be directed to military communication and computer development.
Plant and technology for producing copper-clad, phenol-resin laminated sheet. Plant would have monthly capacity of 15,000 square meters of circuit boards. Chinese were provided with technical brochures on all machinery, general information on manufacturing process, and suggested plant layout. (Inquiry)	Such plant and technology is necessary for serial production of printed circuits needed for various advanced weapons applications, including the development of on-board guidance and control systems for missiles.